Coal Workers’ Pneumoconiosis: A Study of Prevalence in Coal Mines of Eastern Madhya Pradesh and Orissa States of India

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Abstract: With objective to find out prevalence of Coal Worker’s Pneumoconiosis and variation among readers in reading x-ray plates for pneumoconiosis, a retrospective epidemiological survey of Coal Worker’s Pneumoconiosis was undertaken in 72 collieries of Madhya Pradesh and Orissa by re-reading of x-ray plates taken during the Periodical Medical Examination at the Occupational Health Units over a period of 5 years. Six readers, trained abroad in reading pneumoconiosis x-ray plates, were involved for the study. Each reader reported approximately one sixth of the available x-ray plates of all the collieries and classified on the 12 point scale of I.L.O. (International Labour Organisation) 1980 in special format. Total 43,504 chest x-rays were reviewed. The overall prevalence was found to be 3.03%, ranging from 1.52% to 4.76% between 10 areas (group of mines). Major category of profusion was category-I (81.09%), followed by category-II (17.84%). Only 3 cases of Progressive Massive Fibrosis (PMF) were detected. Round shaped opacities are predominant (89.59%) in Coal Worker’s Pneumoconiosis. Among the opacities, ‘p’ type is more prevalent (48.29%) followed by ‘q’ type (40.62%). There was variation amongst the different readers and ranged from 1.14% to 6.76% for reporting the prevalence of Coal Worker’s Pneumoconiosis. However, when analysis of six readers for inter reader variation was conducted, that shows no abnormal deviation in the reading of any of the readers.

Key words: Pneumoconiosis, Periodical Medical Examination, Category, Profusion, Prevalence, Opacity, Irregular, Rounded

Introduction

The coal mines in India were nationalised in 1973. The South Eastern Coalfields Ltd. (S.E.C.L.), which is a subsidiary of Coal India Ltd. (C.I.L.), was consisting of the coal mines of eastern Madhya Pradesh and Orissa spread over 10 areas and consisting of 72 collieries, both underground and open cast. Before nationalisation, medical facilities were imparted to the workers in an unorganised manner and were mostly curative without having any facilities for preventive check up. After it became an organised sector, due importance has been given for routine health check up of the workers with an objective to detect and prevent the disease at the earliest. At the same time, efforts have been made to detect the occupational diseases amongst the coal miners; of which Coal Workers Pneumoconiosis (C.W.P.) is the foremost.

In 1978, the Mines Act was amended vide which Periodical Medical Examination (P.M.E.) of all persons working in mines were made compulsory as well as the Initial Medical Examination (I.M.E.) as provided in Sec. 29 B of the Mines Rules. It stated that all workers have to undergo a P.M.E

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once in every 5 years. This was not only to ensure the early
detection of occupational diseases but also to keep the
workforce healthy by arranging a system of medical
examination.

C.W.P has been made a notifiable disease under Mines
Act and is a compensable disease as per the Workmen’s
Compensation Act. So, its early detection and prevention
becomes utmost important to the management. Although
many studies have been undertaken in different coalfields
in India to find the prevalence of C.W.P, the exact prevalence
of C.W.P in the various region of the country is still unknown.

The prevalence of C.W.P could not be detected accurately
as the methods of radiological interpretation were not
standardised and standard International Labour Organisation
(I.L.O.) x-ray films of pneumoconiosis were not widely used.

In 1988, the British Overseas Development Administration
funded a programme to assist in preventing pneumoconiosis. As
a part of this, an extensive programme of teaching the
doctors of C.I.L in the use of standard I.L.O. films took
place. Following this, it was decided to re-read a large sample
of the chest x-ray films taken over the previous five years in
order to estimate the prevalence of C.W.P in S.E.C.L., which
covers coal mines of eastern Madhya Pradesh and
Orissa. Hence, a research project was undertaken by S.E.C.L.
under “Health of Coal Miners Project” to study the prevalence
of C.W.P in this part of India and compare it with the previous
estimate.

The aim of the study was

1) to determine the prevalence of Coal Worker’s
Pneumoconiosis in eastern Madhya Pradesh and Orissa,
2) to study the improvement in x-ray plate reading by regular
use of standard I.L.O. films for detection of Coal Worker’s
Pneumoconiosis and
3) to study the consistency of six readers.

**Materials and Methods**

S.E.C.L. consisted of coalfield areas of Madhya Pradesh
and Orissa during the study period, distributed in 10 areas
covering 72 collieries which included both open cast and
underground mines. Each area has an Occupational Health
Unit (O.H.U.) under a senior doctor, equipped with a
minimum 300 M.A. x-ray machine, standard 1980 I.L.O.
films of pneumoconiosis, and with all facilities for thorough
clinical examination and investigation. The P.M.E. of all
the workers of that area are conducted in the O.H.U. and
the x-ray plates are stored there, colliery-wise and year-wise,
thus separating those of open cast workers from the
underground.

A retrospective epidemiological survey of C.W.P. was
conducted in S.E.C.L. by studying the P.M.E. x-ray plates
of underground workers taken during the study period of
five years i.e. 1986 to 1990, and kept in the O.H.U. of the
area.

The underground population of S.E.C.L. was 84,896 at
the onset of the project, after starting the P.M.E in all the
areas through the O.H.U., 75,351 underground workers who
reported for P.M.E were examined between 1986 to 1990.
During the same period 580 cases were suspected to be
suffering from C.W.P, which were referred to the
Pneumoconiosis Medical Board by doctors who were in-
charge of O.H.U; giving a prevalence of 0.77%.

Out of 75,351 films taken during 1986–90, depending
upon availability of records and acceptability of x-ray plate
for reading purpose, all the 43,504 films of grade 1 to 3
were taken for re-reading. Grade 4 quality films were
excluded.

Six readers trained in reading pneumoconiosis x-ray plates
in accordance with the I.L.O. 1980 standard classification
of pneumoconiosis and had received training from the
Institute of Occupational Health, Edinburgh (U.K.), were
taken as readers for the study of the P.M.E. films. Before
starting the reading of x-ray plates, a meeting was conducted
with the readers where the norms of the reading and other
procedures were discussed in details. The films were read
strictly according to the I.L.O. classification and invariably
compared with the standard I.L.O. films of pneumoconiosis,
which were available at all the O.H.U. in the areas.

All the readers had to visit each O.H.U. of the area where
they read approximately one-sixth of the available x-ray
plates of all the collieries thereby ensuring that each reader
has read approximately similar number of films from all
parts of S.E.C.L. Films were classified by each reader on
the 12 point scale, using all letters and symbols. Recording
of grade 1/0 or over was taken as pneumoconiosis. A special
format has been prepared to record the x-ray reading by
each reader. To minimise the inter reader variation, 2
agreement session had been conducted, one at the beginning
and another at the middle of the study, in which 100 films
were read by all the readers. After completion of the
epidemiological x-ray reading in all the O.H.U. in the areas,
the records were brought to the Corporate Centre where the
data were processed at the Occupational Health Cell. The
reports had been analysed with respect to the prevalence of
C.W.P, its radiological presentation, area-wise and colliery-
wise distribution. All the 580 x-ray plates which were referred
to the Pneumoconiosis Board during this period were re-
read among six readers as per the above norms and the data
were added to the films of the concerned area.

After the epidemiological survey was over, an inter-reader
comparison session was conducted to study the inter reader
variability. For this session, 200 films were chosen by random
sampling out of the total study films of the project read by
the readers, by a non-trained reader Industrial Health
Specialist to eliminate any bias. All the 200 films were read
by all the readers separately and the findings were noted in
the special format designed for this purpose. Then the
findings were compared in the 12 point scale and analysed.

### Results

The prevalence rate of C.W.P. in this study comes to 3.03%,
ranging from 1.52% to 4.76% in different areas. It is more
in the Area No. 10 and Area No. 6, whereas it is very less in
Area No. 1. Table 1 shows the prevalence of C.W.P. in
different Areas.

The prevalence rate varies considerably among different
readers. The reader No. 3 has reported prevalence rate of
1.14% whereas reader No. 6 has reported 6.76% so the
reporting range varies between 1.14% and 6.76% in this
study (Table 2).

Most of C.W.P. belong to category I (81.09%). Only 17.84%
were found of category II, while category III cases (1.06%)
were not much in this epidemiological study (Table 3).

In Table 4, it was seen that most of the small opacities in
this study belongs to rounded shape (89.59%). But irregular
shaped opacities are also reported in the study (10.41%) which
are less in number. Among the size of the opacities, ‘p’ type
is most prevalent (48.29%) followed by ‘q’ type (40.62%) in
the rounded shaped opacities. However, it was noted that in
Area Nos. 1 to 4, ‘q’ type of opacities were more prevalent
than ‘p’ type and ‘r’ type of opacities were also seen more
frequently in these areas in comparison to Area Nos. 6 to 10.
Among the irregular shaped opacities ‘s’ type (8.58%) is more
predominant than others (‘t’ 1.75% & ‘u’ 0.08%).

When distribution of profusion and type of small opacities
were compared, it was noted that ‘p’ type opacities are more
prevalent in category I only, while in category II and category

### Table 1. Area wise distribution of pneumoconiosis (small opacities as detected from epidemiological survey)

<table>
<thead>
<tr>
<th>Area code no.</th>
<th>No. of x-ray films read</th>
<th>No. of C.W.P. detected</th>
<th>Prevalence of C.W.P. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2,240</td>
<td>34</td>
<td>1.52</td>
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<tr>
<td>2</td>
<td>4,765</td>
<td>179</td>
<td>3.76</td>
</tr>
<tr>
<td>3</td>
<td>2,206</td>
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<td>4</td>
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<td>5</td>
<td>7,634</td>
<td>232</td>
<td>3.04</td>
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<tr>
<td>6</td>
<td>3,264</td>
<td>154</td>
<td>4.72</td>
</tr>
<tr>
<td>7</td>
<td>2,036</td>
<td>39</td>
<td>1.92</td>
</tr>
<tr>
<td>8</td>
<td>4,599</td>
<td>92</td>
<td>2.00</td>
</tr>
<tr>
<td>9</td>
<td>5,490</td>
<td>105</td>
<td>1.91</td>
</tr>
<tr>
<td>10</td>
<td>4,328</td>
<td>206</td>
<td>4.76</td>
</tr>
<tr>
<td>Total</td>
<td>43,504</td>
<td>1,317</td>
<td>3.03</td>
</tr>
</tbody>
</table>

### Table 2. Table showing reader-wise distribution of x-ray film reading in different areas

<table>
<thead>
<tr>
<th>Area code no.</th>
<th>Reader 1</th>
<th>Reader 2</th>
<th>Reader 3</th>
<th>Reader 4</th>
<th>Reader 5</th>
<th>Reader 6</th>
<th>Study Group**</th>
<th>Total</th>
</tr>
</thead>
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<tr>
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<td>Film PNCN</td>
<td>Film PNCN</td>
<td>Film PNCN</td>
<td>Film PNCN</td>
<td>Film PNCN</td>
<td>Film PNCN</td>
<td>Film PNCN</td>
<td>Film PNCN</td>
</tr>
<tr>
<td>1</td>
<td>337</td>
<td>0</td>
<td>394</td>
<td>3</td>
<td>339</td>
<td>3</td>
<td>224 1</td>
<td>525 5</td>
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<tr>
<td>2</td>
<td>916</td>
<td>22</td>
<td>687</td>
<td>11</td>
<td>951</td>
<td>18</td>
<td>788 20</td>
<td>667 20</td>
</tr>
<tr>
<td>3</td>
<td>284</td>
<td>4</td>
<td>515</td>
<td>7</td>
<td>296</td>
<td>3</td>
<td>123 8</td>
<td>325 12</td>
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<tr>
<td>4</td>
<td>1,521</td>
<td>47</td>
<td>2,342</td>
<td>28</td>
<td>563</td>
<td>2</td>
<td>634 17</td>
<td>707 16</td>
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<tr>
<td>5</td>
<td>2,383</td>
<td>61</td>
<td>962</td>
<td>8</td>
<td>1,331</td>
<td>18</td>
<td>685 37</td>
<td>1,367 22</td>
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<tr>
<td>6</td>
<td>604</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td>645</td>
<td>1</td>
<td>675 24</td>
<td>615 17</td>
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<tr>
<td>7</td>
<td>561</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>464</td>
<td>0</td>
<td>372 3</td>
<td>284 11</td>
</tr>
<tr>
<td>8</td>
<td>394</td>
<td>6</td>
<td>567</td>
<td>6</td>
<td>1,646</td>
<td>19</td>
<td>551 17</td>
<td>870 17</td>
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<tr>
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<td>485</td>
<td>5</td>
<td>848</td>
<td>18</td>
<td>1,006</td>
<td>22</td>
<td>1,634 20</td>
<td>606 11</td>
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<tr>
<td>10</td>
<td>269</td>
<td>3</td>
<td>1,045</td>
<td>17</td>
<td>827</td>
<td>6</td>
<td>657 34</td>
<td>693 65</td>
</tr>
<tr>
<td>Total</td>
<td>7,754</td>
<td>189</td>
<td>7,360</td>
<td>98</td>
<td>8,068</td>
<td>92</td>
<td>6,343 181</td>
<td>6,659 196</td>
</tr>
<tr>
<td>Prevalence (%)</td>
<td>2.44</td>
<td>1.33</td>
<td>1.14</td>
<td>2.85</td>
<td>2.94</td>
<td>6.76</td>
<td>3.03</td>
<td></td>
</tr>
</tbody>
</table>

*PNCN = Pneumoconiosis, **Study Group = Reader 1 to 6. 580 films were referred to pneumoconiosis board by doctors in charge of different OHUs from the 75,351 films seen by them. These films were divided amongst the ‘Study Group’ and the result is entered in the table.
III, 'q' type opacities are more prevalent (Table 5).

In Table 6, to determine the improvement in x-ray plate reading for detection of C.W.P. using standard I.L.O. plates; the formally trained readers and non-trained readers are divided into two groups:

Group-A: Six readers who received formal training and used I.L.O. plates.
Group-B: Other readers (doctors in-charge of O.H.U.) who did not receive formal training and used I.L.O. plate sparingly (but read these plates during P.M.E.).
From this table, it is clear that Group-A has detected more C.W.P. from the same study population i.e. formal training and use of I.L.O. plates improve the detection of C.W.P. from the similar study population, other relevant factors being equal.

To study the consistency of reading of C.W.P. of the six readers, the recording of category profusion was converted to the corresponding numerical point based on the 12 point scale for each x-ray film. Then the total of the 200 films which all readers have read independently were summed up for each reader (x), which has been given below. When analysis of six readers for inter reader variation was conducted by study of these films, that shows no abnormal deviation in the reading of any of the readers. Hence, it is seen that the relative Standard Variate (Z) is within ± 2 Standard Deviations from the mean, for all the readers. So there was no abnormal variation.

### Discussion

C.W.P. is quite prevalent in coal mines all over the world. Reports of occupational lung diseases occurring amongst coal miners made their appearance in early nineteenth century in U.K. Laennec (1806) described a peculiar form of reaction which he called ‘Melanosis.’ In 1831, Thakaray described a condition called ‘Miner’s Asthma’ among coal miners. Till the work of Collis et al.11, pneumoconiosis in coal miners were believed to be due to quartz; when finally it was shown that coal trimmers who were exposed to dust containing little free silica developed similar radiological lesion.

The prevalence rate of the disease has been reported in many countries12. In U.S.A. (1969–71), in the first round inter agency study, over 9,000 miners in 31 coal mines were examined giving an overall prevalence of 30%. In the 2nd and 3rd inter agency study, the prevalence rate were reported as 8% and 5% respectively. In France, the prevalence rate was around 12%. In Australia (1963–65), the prevalence rate was 3%. In Korea (1982–85), a study was conducted among 2,400 workers in 52 collieries where the prevalence rate was reported as 13.8%. In U.K. (1951–53), the prevalence rate has been reported as 5.7% in Scottish mines. Then there was an extensive, systematic study by the National Coal Board through its Pneumoconiosis Field Research, with follow-up studies in subsequent years. In 1959–63, they reported the prevalence rate as 4.2%.

The existence of C.W.P. has been reported in Indian mines from time to time. Deshpande13 reported no evidence of occupational lung diseases in Indian coal mines. However, Roy14 reported a prevalence of 15%. In a pilot survey conducted in the coalfields of Jharia in 1960–6115, the prevalence rate was found to be 18.6%. This high prevalence of C.W.P. was thought to be due to the fact that only underground workers with over ten years duration of service were taken as the study population. In another study conducted by the Central Mines Research Station (C.M.R.S.) at Jharia coalfields in 1964–65, a total of 952 workers were examined and the prevalence rate was found to be 7%. Between, 1965–70, Vishwanathan R. et al.16 of Rajendra Memorial Research Institute of Medical Sciences, Patna conducted a well planned survey at Dhanbad-Jharia coalfields in Bihar. They examined 8,822 workers basing on I.L.O.-1958 standard classification and found the prevalence rate to be 10.8%. In another study at Jamadolia coalfields conducted by C.M.R.S. in 1977, they examined 455 workers and found a prevalence of 3.5%.

Out of total employees i.e. 84,896 during the period of 1986–90, 75,351 were examined in P.M.E. In this study,
depending upon availability of records and radiographs, excluding grade 4 quality films, all remaining 43,504 films were examined from different coalfields of Madhya Pradesh and Orissa. The mean prevalence of all areas surveyed was found to be 3.03%, with the range varying from 1.52% to 4.76% in the different coal mining areas. The prevalence noted in this study is less than most of the earlier studies. Decreased prevalence observed in this study could be due to use of 1980 I.L.O. classification.

Beside that, surface worker and workers with less years of service were not excluded, as was done in some studies. Thirdly, this difference could be due to geographical reasons as studies quoted earlier has been carried out in states of Bihar and Bengal and the present study is of mines from Madhya Pradesh and Orissa. This may be quite significant, as the type of coal and working conditions may vary. The significance of this variation in different areas (1.52% to 4.76%) is not clearly understood at this stage of our study, but it is worthwhile to mention that in these extreme cases the aetiological factors influencing C.W.P. may have been different. The study of other factors like dust concentration in mines, quartz content, other environmental mining conditions, etc. could have thrown some light regarding the high or low prevalence in particular areas and individual mines.

It is noted that the major category of profusion was category-I (81.09%) followed by category-II (17.84%) and category-III (1.06%). Jacobson has also noted increased prevalence of category I in comparison to category II and least prevalent was category III. This may be due to the fact that the progress of C.W.P. is slow in Indian mines for which other aetiological factors may be investigated. This is also supported by the fact that only 3 cases of P.M.F. were detected giving prevalence of 0.0066% and 0.16% of pneumoconiosis cases. Hurley et al. have observed that the attack rate of P.M.F. increases with increasing degree of simple pneumoconiosis as most of the cases in this study were category I, hence decrease in PMF. This is much less in comparison to first round of interagency study carried out in 1969 in U.S.A. which showed 2.5% had P.M.F. And the finding at the third round were just 0.17% P.M.F. Patnaik and Parihar showed that P.M.F. constituted 4.94% of total cases of pneumoconiosis. Shrivastava et al. reported prevalence of P.M.F. as 5.1% of total pneumoconiosis cases diagnosed. In Viswanathan et al. study the prevalence of P.M.F. was 0.2% and constituted 1.7% of total cases of pneumoconiosis. The difference in our study could be due to regional variation which may be responsible for both decreased prevalence and P.M.F.

From the analysis shown in Table 4, it may be noted that round shaped opacities are predominant (89.59%) in C.W.P. The present study also noted that there are irregular shaped opacities also, although less in number. Collins et al. found irregularly shaped opacities in their study of Coalworkers' Pneumoconiosis and are of opinion that small irregular opacities should be taken into consideration when assessing the severity of coalworkers' simple pneumoconiosis. However, Miller et al. have agreed that in coal worker's simple pneumoconiosis the small opacities are usually rounded in shape but some researchers have reported that some radiographs of coal workers show irregular opacities, although there has been disagreement about relevance of such observation; and for epidemiological studies it is not of major importance to distinguish small rounded from small irregular opacities.

Although, overall preponderance of 'p' type opacities were noted (48.29%), followed by 'q' type (40.62%) but it was observed that in certain areas (Nos. 1 to 4) where 'q' opacities were most prevalent, 'r' type of opacities were also seen more frequently, in comparison to areas where 'p' opacities were predominant (except Area No. 5). To establish the reason, further study is needed on the factors such as quality of coal, quartz content, degree of mechanisation, dust level etc. which may be responsible for such finding. It was also noted that difference between profusion in Cat.I and Cat.II (81.09% & 17.84%) was more than that of between type of opacities. When the category of profusion is compared with the type of opacity, it is found that the 'p' type is more predominant in Category I whereas the 'q' type is more so in Categories II & III. It is suggestive of that with progression in category, there is also increase in size of opacity.

Study shows significant increase in detection of pneumoconiosis by use of standard I.L.O. plates (Table 6). Prior to its use, the prevalence was 0.77% and in the present study it was found to be 3.03%. It indicates that plates were under-read before the use of I.L.O. films (1980). Contrary to the findings of first and second round of interagency study, where re-reading with the use of standard I.L.O. films led to a significant reduction in the prevalence of pneumoconiosis; in this study, there is increase in detection of pneumoconiosis.

It is noted that there is a significant variation amongst the different readers in reporting prevalence of C.W.P. from the x-ray plates which ranged from 1.14% to 6.76% (Table 2). In the study of 200 x-ray films read by all the 6 readers, there was disagreement in 52 films (26%). Of these 52 films,
there was gross disagreement in 2 films (1%). In 43 films (21.5% of total) there was agreement among 5 readers and only one of the reader disagreed. In the rest 7 films, any 4 of the readers in each case was in agreement while 2 readers disagreed. Amongst all the readers, reader no. 5 had most of the disagreements (21 films) followed by reader no. 1 (12 films). As these variation was mostly seen in categorisation of 0/0 to 1/1, that may make a film positive or negative for pneumoconiosis without significant variation. This may be one of the reasons for different prevalence among 6 readers, while no significant difference noted during inter reader study.

Jacobson M. et al. (1984) of U.K. acknowledged the variabilities amongst the readers in the use of I.L.O. classification; but nevertheless, feels encouraged by the fact despite the variability, the average results from a well designed and conducted study can demonstrate plausible trends and generate useful information. Mush et al. (1985) reported using I.L.O.-1971 classification by three experienced readers for signs of simple pneumoconiosis; there were variation from 63 (8.5%) to 114 (15.3%) for the 743 x-ray radiographs. Most of the differences occurred in the categorisation of 0 and 1. Similar experiences of differences were noted amongst readers of Pneumoconiosis Field Research in U.K.

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